Physics 11 Review

There are a few things you should remember from Physics 11:

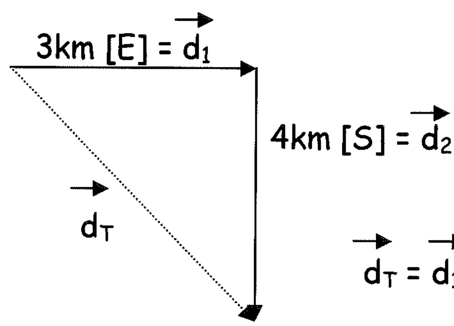
There are **two types of measurements**:

Scalar – have only magnitude (amount) i.e. 12 $^{m}/_{s}$, 5N, distance = d = 3km

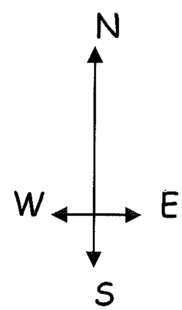
Vector – have magnitude (amount) and direction: i.e. 12 $^{m}/_{s}$ East, 5N down

Length of arrow shows magnitude

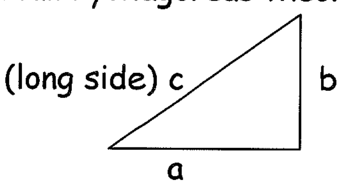
Direction of arrow shows direction



$\vec{d_T} = \vec{d_1} + \vec{d_2}$



Recall Pythagoreas theorem:



short sides   long side

$$a^2 + b^2 = c^2$$

$$(3km)^2 + (4km)^2 = 9\ km^2 + 16\ km^2 = 25\ km$$

$$d_T = 5km\ [SE]$$

Velocity = $\frac{\text{displacement}}{\text{time}}$ or $v = \frac{d}{t}$

Displacement is a **vector**, thus velocity is a **vector** also.

Acceleration - the change in velocity per unit time

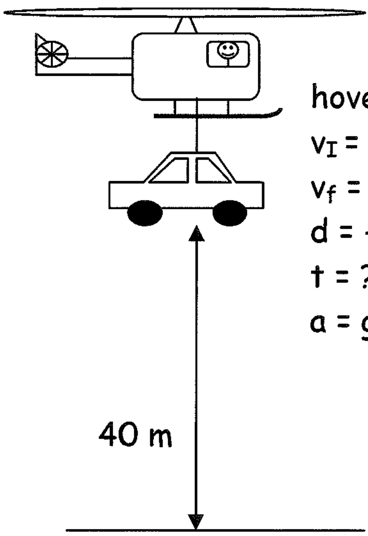
The equations we need to solve questions involving uniform motion:

$v_f = at + v_i$ $v_f^2 = v_i^2 + 2ad$

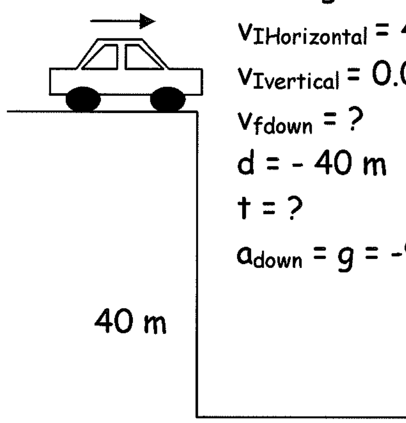
$d = v_i t + \frac{1}{2}at^2$ $d = \frac{1}{2}(v_i + v_f)t$

Acceleration due to Gravity or Things Fall. Remember that all things fall down. This is due to gravity - all matter attracts all other matter. Here on the surface of the Earth all objects accelerate downwards at $9.8\,^{m}/_{s}{}^{2}$.

Also, an object moving horizontally and one dropped vertically will fall the same distance in the same time with the same vertical speed.



hovering
$v_I = 0.0\,^{m}/_{s}$
$v_f = ?$
$d = -40$ m
$t = ?$
$a = g = -9.8\,^{m}/_{s}{}^{2}$



driving
$v_{IHorizontal} = 40.0\,^{km}/_{h}$
$v_{Ivertical} = 0.0\,^{km}/_{h}$
$v_{fdown} = ?$
$d = -40$ m
$t = ?$
$a_{down} = g = -9.8\,^{m}/_{s}{}^{2}$

Projectiles - objects that move horizontally and vertically at the same time?
There are two important things to note:
1. The times t_x and t_y are the same - however long the car is falling (t_y) is the same amount of time that the car is moving across (t_x).
2. In the x direction, the velocity is constant - once the car leave the cliff, the wheels are not pushing on the ground, so there is no acceleration

Forces -A force is a push or a pull (or a twist).

Newton's First Law of Motion - if no net force acts on an object, it maintains its state of rest or movement. If the forces are not balanced ($F_{net} \neq 0$) the object will accelerate in the direction of the net force.

Newtons Second Law of Motion - the acceleration depends directly on the net force and inversely on the mass of the object being moved. This is usually written:

$F = ma$ where F = force applied (or unbalanced) in Newtons
m = mass of object in kilograms
a = acceleration of the object in $^{m}/_{s}{}^{2}$

Newtons Third Law of Motion states that for every force, there is an equal and opposite reaction force (forces act in pairs). This applies to forces acting between two bodies.

Friction -When you apply a force to an object, sometimes it will not move - this is because of friction. Friction is the force of resistance that occures whenever two objects come into contact and move relative to each other. We show friction (F_f) as a force in the direction opposite to the direction of motion.

Gravity -is the force of attraction that exists between all objects with mass. There is a force of gravity between you and the piece of paper (or computer screen) that you are reading this on. This force is only noticeable if one or both of the objects are massive. **Law of Universal Gravitation** - every object in the universe is attracted to every other object in the universe.

$F_A = \frac{Gm_1m_2}{d^2}$ where F_A = force of attraction between two objects (N)

m_1 = mass of one object (kg)

m_2 = mass of second object (kg)

d = distances between the **centers** of the masses (m)

G = universal gravitational constant $6.67*10^{-11}\ {}^{Nm^2}/_{kg^2}$

Momentum - Recall that a force is a push or pull. However, when we apply a force, we also want to know how long we are applying the force. Momentum is a measurement of how long a force has been applied.

Momentum p = Force applied * time force is applied, or p = F * t

Recall Newton's second law F = ma.

$$F = ma = \frac{mv}{t} \longrightarrow Ft = mv \longrightarrow \text{But } p = Ft\text{, so } \mathbf{p = Ft = mv}$$

This means that we can calculate the momentum of an object by measuring the mass and the velocity of the object. Note also that the change in momentum is called the impulse:

Impulse = $\Delta p = \Delta Ft = \Delta mv$

Work – here in physics we define physical work as what happens when a force is applied and moves an object:

$W = F_A * d$ where W = work done, in joules $J = Nm = {}^{kgm2}/_{s}{}^{2}$
F_A = force applied, in Newtons N
d = distance moved, in meters m

Power - the rate at which work is done.

$P = \frac{W}{t}$ where P = power, in ${}^{J}/_{s}$ = Watt (W)
W = work done, in J
t = time taken, in s

Note W = work done, and Watts (W) is the unit of power – please do not mix them up.

Energy – in physics, we usually define energy as the ability to do work. Each time you do work, you are transferring energy for the object you are doing work to the object being worked on.

There are many types of energy – one is Gravitational Potential Energy (GPE), often referred to as **Potential Energy** (PE). If you pick up an object, of mass m, up a height h, then you are doing work on the object. Note that here you have transferred energy to the object: $\Delta E = W = mgh = \Delta PE$. Note that the potential energy of the object depends on its mass, gravitational field strength and its height above the surface.

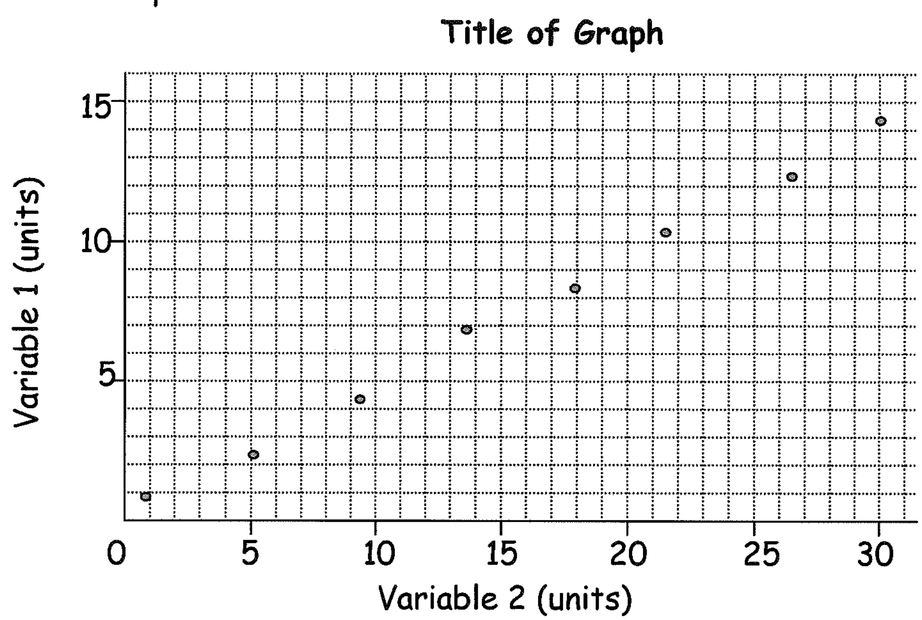
Kinetic energy - the energy of a moving object. To get an object to move, you must do work on it and transfer energy = $\frac{1}{2}mv^2$

The **law of conservation of energy** states that energy can not be created or destroyed, only transformed from one type to another. Here we are concerned with stored energy (potential energy PE), and energy of motion (kinetic energy KE).

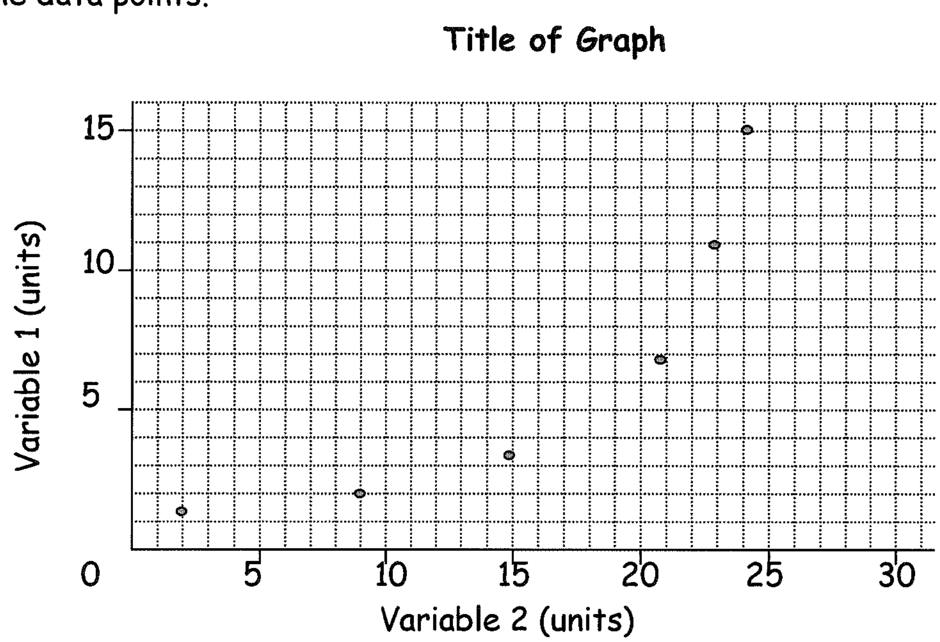
How to Make Graphs

In science we usually produce graphs after doing an experiment. This involves plotting one set of data with another set of data. In science we usually deal with line graphs. Line graphs can be linear or nonlinear.

A linear graph is a graph that would allow you to draw a straight line through most or all of the data points.



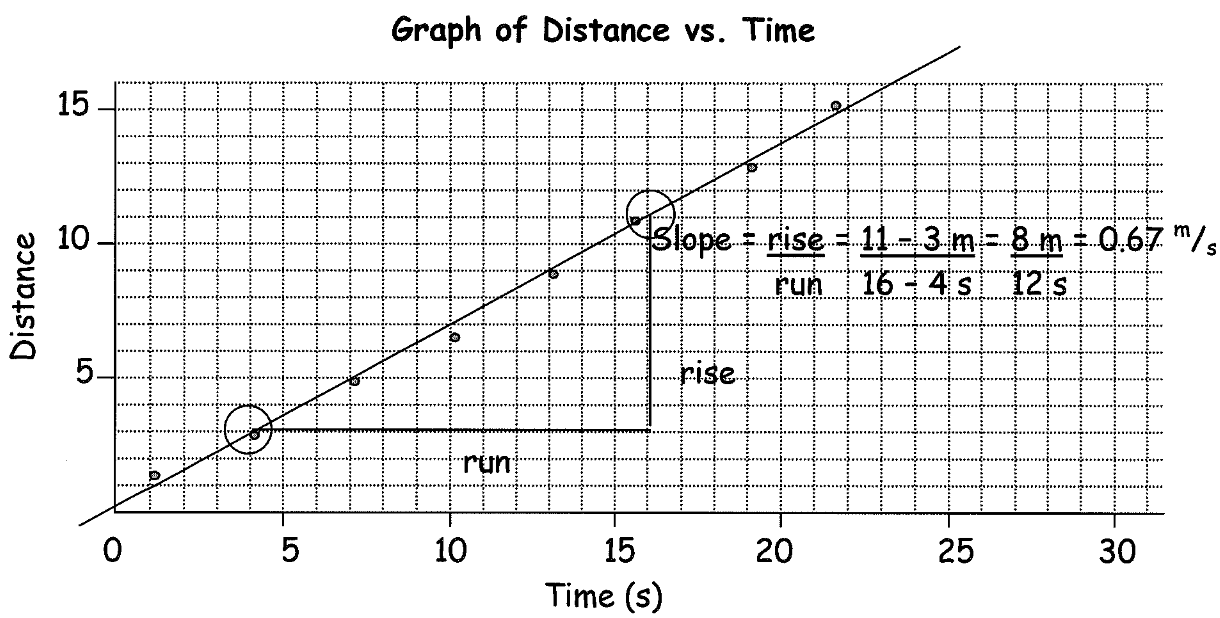
A non-linear graph is a graph that would allow you to draw a curve through most or all of the data points.



You will have to decide if the graph you produce is linear or non-linear. If the graph is non-linear, then you must do more complicated graphing techniques that we will cover later. If the graph is linear, then you must draw in your best straight line (**do not play connect the dots**) and come up with an equation for the line. The equation helps describe the relationship that exists between the variables being plotted.

Once you have plotted the data involved, and drawn your best straight line, you then determine the slope of the graph and find the equation.

Example Graph:
Carefully examine the graph. Its characteristics are listed below the graph.



Characteristics of a good graph:

Size - should take up most of the graph paper. Usually only one graph per page.

Title- this should represent the experiment, and close to the actual graph, at the top of the graph.

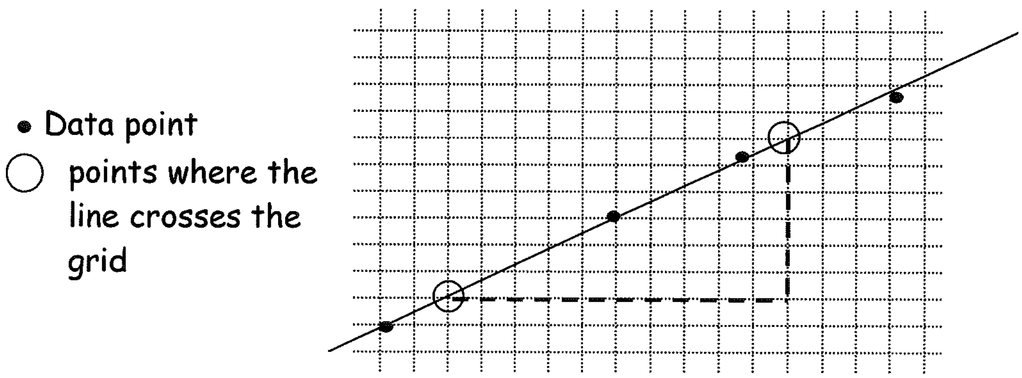
Both axes labeled and with units - showing the quantity, the abbreviation of the quantity, and the abbreviation of the unit in parenthesis. Ex. V volume (ml)

Both axes have appropriate scales - increment should be a factor of 1, 2, 5, or 10. Never use 3 or 7.

Chose a scale so that the graph line goes up in the centre of the page, not near one of the axes, and that the data graphs nearly all the way up the page, but is still easy to read.

A best fit straight line should be drawn through most data points - this line does not have to include all data points (**do not play connect the dots**), but should have as many points above the line as below the line if possible.

Slope points shown, with coordinate pair to at least two significant figures. The slope points usually will not be data points, but are points where the line crosses the grid of the graph paper. Intersections of the line and grid are easiest to read and therefore lead to better accuracy.



Slope calculations shown (with units) - show two or three significant digits in the number.

Equation shown with correct variables, units, and vertical axis intersection - this represents the relationship between the two variables in the experiment. The slope is very important and usually represents some concept.

Here you have to recall some grade ten math - the equation of a straight line is

$y = mx + b$ where
- y is the variable on the 'y' (vertical) axis
- x is the variable on the 'x' (horizontal) axis
- b is the y intercept - where the best fit straight line touches the y axis
- m is the slope of the line

Recall that slope of the line is the rise divided by the run = m

$$m = \Delta y/\Delta x = (y_2 - y_1)/(x_2 - x_1)$$

Note - you should try to decide if the origin (0,0) is a logical data point.

Sample Graphing Question - A physics teacher was running down the hallway. A student recorded the following data:

Time (s)	0	1	2	3	4	6	8	10	12	14	16
Distance(m)	0	3	7	10	14	21	28	35	41	48	55

Plot the data on a graph.

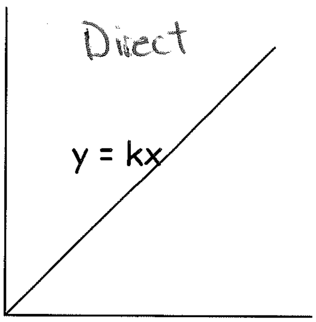
1. What is the slope of the line?
2. What is the speed of the physics teacher?
3. From your graph, at what time is the teacher (a) 15 m down the hall?
   (b) 45 m down the hall?
4. From your graph, how far down the hall is the teacher at (a) 5 s?
   (b) 15 s?

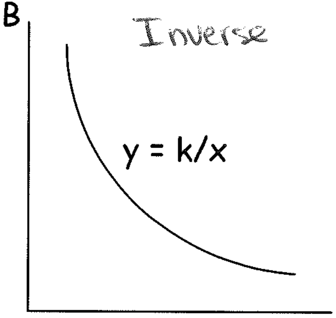
Answers 1. 3.5 $^{m}/_{s}$ 2. 3.5 $^{m}/_{s}$ 3. (a) 4.3 s (b) 13 s 4. (a) 17 m (b) 52 m

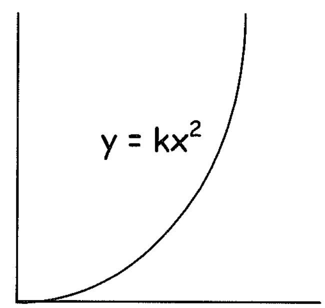
INTERPRETING GRAPHS

In laboratory investigations, you generally control one variable and measure the effect it has on another variable while you hold all other factors constant. For example, you might vary the force on a cart and measure its acceleration while you keep the mass of the cart constant. After the data are collected, you then make a graph of acceleration versus force using the techniques for good graphing. The graph gives you a better understanding of the relationship between the two variables.

There are three relationships that occur frequently in science. If the dependent variable varies directly with the independent variable, the graph will be a straight line, as shown in graph A. If y varies inversely with x, the graph will be a hyperbola as shown in graph B. The third relationship, in which y varies directly with the square of x, gives a parabola (graph C).

A


B


C


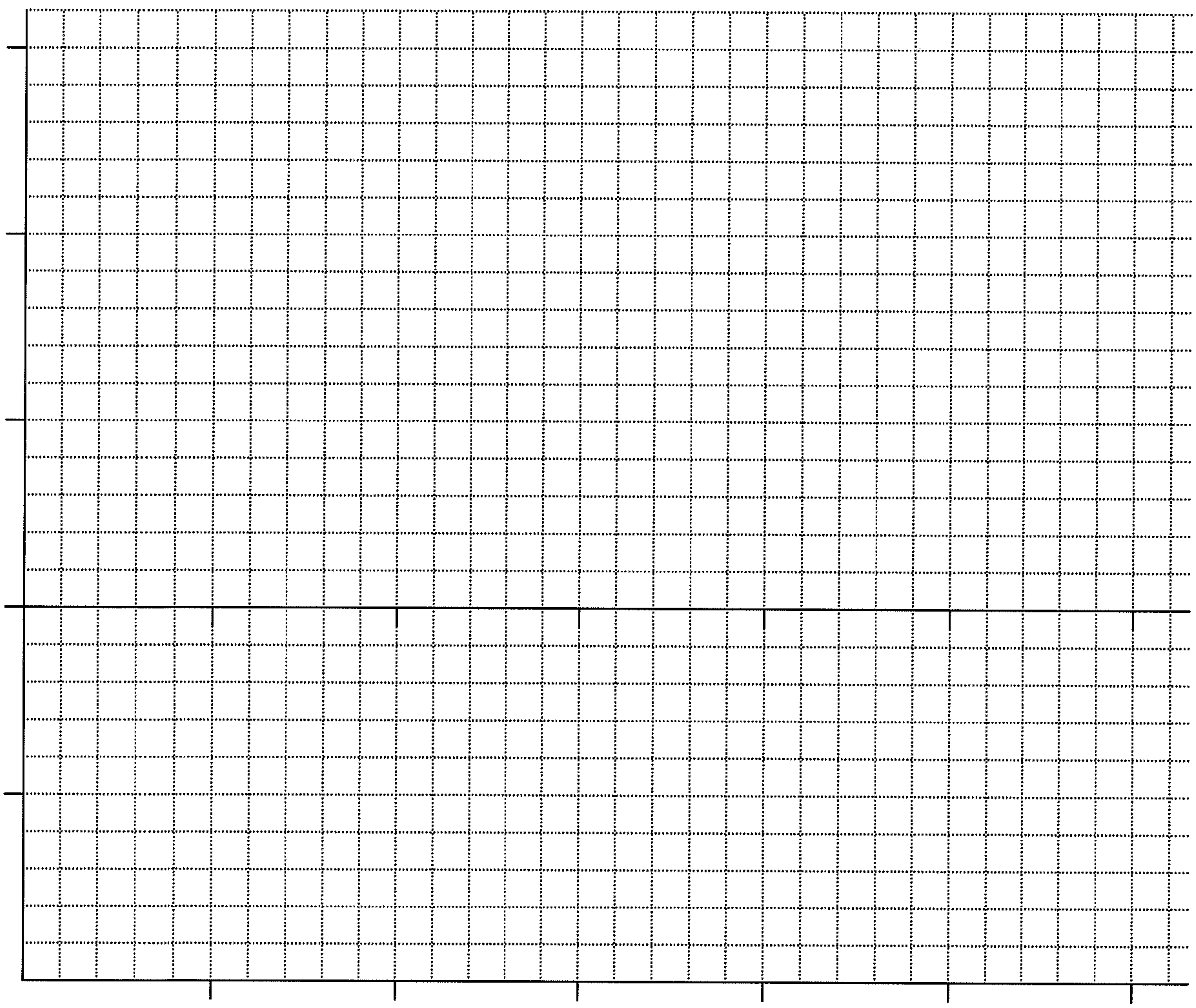
Sometimes you need information about a value that you have not determined experimentally. Reading from the graph between data points is called **interpolation**. Reading from the graph beyond the limits of your experimentally determined data points is called **extrapolation**. Extrapolation must be used with caution because you cannot be sure that the relationship between the variables remains the same beyond the limits of your investigation.

Graphing Worksheet#2

____
(name)

1. The following data show the distance an object travels in certain time periods. Prepare a graph showing these data.

Time (s)	Distance (cm)
0	0
1	3
2	12
3	27
4	48

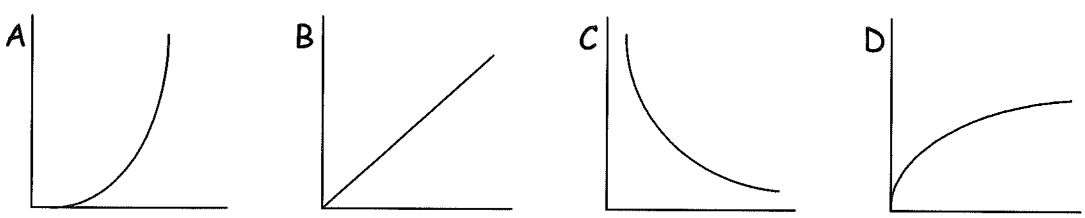


(a) Describe the relationship between x and y and write a general equation for the curve.

(b) Is the distance traveled greater between 0 s and 1 s or 3 s and 4 s?

(c) is the slope of the curve greater between 1 s and 2 s or 3 s and 4 s?

Answer questions 2 & 3 that refer to the following graphs.



2. Which of the above graphs represents an inverse relationship?

3. Which of the above graphs could have the equation $y = kW^2$?

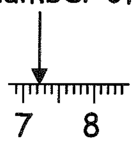
Answers:

1. a. $d = kt^2$ b. 3 s and 4 s c. 3 s and 4 s 2. C 4. A

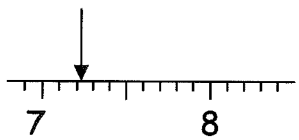
K=3 here

Significant Digits or Your Ruler Lies

There is uncertainty in any measurement. The accuracy of a measurement is shown by the number of figures or digits recorded.



For example, in this example, what is the measurement? 7 cm? 7.2 cm? 7.3 cm?

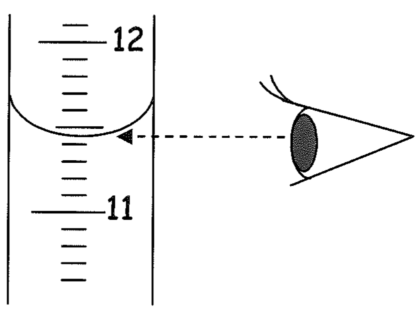


Look at it closer - what is the measurement? 7.21 cm? 7.22 cm? 7.23 cm?

Here we can all agree that the measurement is around 7.2 cm. Unfortunately, the last digit is open to debate - it is an educated guess or estimate that we can not completely trust. Hence, in calculations we can not completely trust the answers from our calculations.

A measurement of 7.22 cm is more accurate than one of 7.2 cm. Therefore, we say that 7.22 has '3' significant figures or digits, and that 7.2 has '2' significant figures (abbreviated sig. figs.). The digits in a number that are known to be reliable or accurate are significant.

Similarly, a recorded weight of 3.4062 g observed with an analytical balance, means that the object was weighed to the nearest tenth of a milligram and represents five significant figures (3,4,0,6,2), the last figure (2) being reasonably correct.



A 50-ml burette has markings 1/10 ml apart, and the hundredths of a ml are estimated. The volume here of 11.45 ml represents four significant figures. The last figure (the 5), being estimated may be in error by one or two digits in either direction. The preceding three figures (1,1,4) are completely certain.

In elementary measurements in chemistry and physics, **the last figure is estimated and is also considered as a significant figure.**

Zeroes

Zeros may or may not be significant. It depends upon how they are used.

eg.	50	has 1 sig. fig.
	50.	has 2 sig. figs.
	50.0	has 3 sig. figs.
	50.002	has 5 sig. figs.
but	0.0005	has 1 sig. figs.
	0.00050	has 2 sig. figs.

A number like '600' may have 1 sig. figs. or more, depending upon how it is used. For example, in the two sentences describing '600':

'I think I have $600 in my account.'

'I counted exactly 600 people in this room.'

The first '600' is only a guessing number and has only 1 sig. figs., but the second '600' is a counting number and all counting numbers have infinite sig. figs.

eg. 600 = 600.0000000000000000000.........

Also, '600' may be expressed with 1, 2, 3 or more sig. figs. by using scientific notation.

$600 = 6 \times 10^2$	1 sig. fig.
$= 6.0 \times 10^2$	2 sig. figs.
$= 6.00 \times 10^2$	3 sig. figs.
etc.	

A recorded volume of 28 ml represents two significant figures (2,8). If this same volume were written as 0.028 liter it would still contain only two significant figures. Zeros appearing as the first figures of a number are not significant since they merely locate the decimal point. However, the values 0.0280L and 0.280L represent three significant figures (2,8, and the last zero); the value 1.028 L represents four significant figures (1,0,2,8); and the value 1.0280 L represents five significant figures (1,0,2,8,0).

If a truck has a mass of 9800 kg - this is not accurate. The last two zeros may have been used merely to locate the decimal point. If it was weighed to the nearest hundred kilograms, the mass contains only two significant figures and may be written exponentially as 9.8×10^3 kg. If massed to the nearest ten kilograms it may be written as 9.80×10^3 kg, (three sig. figs.). Since the zero in this case is not needed to locate the decimal point, it must be a significant figure. If the object was weighed to the nearest kilogram, the mass could be written as 9.800×10^3 kg (four sig. figs).

Rounding Off

A number is rounded off to the desired number of significant figures by dropping one or more digits to the right. When the first digit dropped is less than 5, the last digit retained should remain unchanged (i.e 7.44 becomes 7.4), and when it is more than 5, 1 is added to the last digit retained (i.e 8.68 becomes 8.7). Thus successive approximations to 3.14159 are 3.1416, 3.142, 3.14, 3.1, and 3.

When the digit to the right of the desired number of sig. figs. is exactly 5, 1 is added to the last digit retained if that digit is odd; otherwise it is dropped (odd round up, even round down to always get an even number). For example, to round off these numbers to three sig. figs:

$41.0 \longleftarrow 41.05$

$41.15 \longrightarrow 41.2$

$41.2 \longleftarrow 41.25$

$41.35 \longrightarrow 41.4$

$41.4 \longleftarrow 41.45$

$41.55 \longrightarrow 41.6$

$41.6 \longleftarrow 41.65$

$41.75 \longrightarrow 41.8$

$41.8 \longleftarrow 41.85$

$41.95 \longrightarrow 42.0$